

REMARKS

Claims 40, 43-47, 68, 71-72, and 74-75 have been amended. Claims 40, 43-51, 68-72, and 74-86 are pending. The Title of the Invention has been amended to correspond more closely to the pending claims. Applicant reserves the right to pursue the original claims and other claims in this and other applications. Applicant respectfully requests reconsideration of the above-referenced application in light of the amendments and foregoing remarks.

At the outset, Applicant acknowledges with appreciation that claims 76-86 have been allowed. Applicant respectfully submits that claims 40, 43-47, 68, 71-72, and 74-75, now also contain allowable subject matter for at least the following reasons.

Claims 40, 43-49, 68, 71-72 and 74-75 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 5,925,931 ("Yamamoto") in view of U.S. Patent No. 6,249,347 ("Svetkoff"). The rejection is respectfully traversed.

Claim 40 recites a semiconductor device comprising, *inter alia*, "a semiconductor structure having at least one metal layer . . . a first insulator layer formed on said at least one metal contact layer; at least one metal pad . . . a second insulator layer formed on said at least one metal pad and at least a portion of said first insulator layer; and at least one solder contact ball formed in the second insulator layer . . . having a diameter less than 100 microns."

Claim 71 recites a semiconductor device with at least one metal contact layer comprising, *inter alia*, "a first insulating layer formed over and in contact with said at least one metal contact layer; and at least one solder contact ball formed in the first insulating layer . . . [which] has a diameter between 2 and 100 microns." See FIG. 5E of Applicant's specification for support of this claim amendment.

Yamamoto discloses a first insulating layer 24, a second insulating layer 41 formed on the first insulating layer 24, and a third insulating layer 47 formed on second insulating layer 41 (FIG. 7). A solder bump 48 is formed in the third insulating layer (FIG. 7). Yamamoto does not teach or suggest a second insulator layer formed on a metal pad and a portion of a first insulator layer, much less at least one solder contact ball formed in the second insulator layer. Similarly, Yamamoto does not teach or suggest at least one solder contact ball formed in the first insulating layer.

The Office Action asserts that Yamamoto discloses “a first insulator layer (24/41 in Fig. 7) overlying the metal contact . . . [and] a second insulator layer (47 in Fig. 7) overlying the metal pad [50].” (Office Action, pg. 3). Claim 40 recites, however, a “first insulator layer formed on said at least one metal contact layer . . . a second insulator layer formed on said at least one metal pad and at least a portion of said first insulator layer . . . [and] at least one solder contact ball formed in the second insulator layer.”

The only element, in Yamamoto’s FIG. 7, that arguably corresponds to Applicant’s claimed first insulator layer is element 24. Element 24 is the only insulating layer, in FIG. 7, that is formed on a metal contact layer. Accordingly, Yamamoto’s second insulator layer 47, as asserted by the Office Action, is not formed on at least a portion of the first insulator layer 24; but, is formed on insulating layer 41. Element 41, in Yamamoto’s FIG. 7, would arguably correspond to Applicant’s claimed second insulator layer; not element 47 as the Office Action asserts. In other words, element 47 is a third insulating layer in Yamamoto’s structure. Thus, solder bump 48 is not formed in insulating layer 41; but, is formed in insulating layer 47, *i.e.*, the third insulating layer of Yamamoto’s structure. Yamamoto simply does not disclose or suggest “at least one solder contact ball formed in the second insulator layer,” as claim 40 recites, or “at least one solder contact ball formed in the first insulating layer,” as claim 71 recites.

Moreover, even assuming *arguendo*, that Yamamoto's element 41 corresponds to Applicant's claimed first insulator layer, as the Office Action asserts in the alternative, the second insulating layer in FIG. 7 would be element 47. Yamamoto's element 41, however, would not be formed on at least one metal contact layer as claim 40 recites. Yamamoto's element 41 is formed entirely on element 24, which is disclosed as being a silicon dioxide layer, *i.e.*, an insulating layer (FIG. 7). In this case, Yamamoto would not disclose or suggest "a first insulator layer formed on said at least one metal contact layer," as recited in claim 40, or "at least one solder contact ball formed in the first insulating layer," as claim 71 recites. Solder bump 48 is formed in insulating layer 47 of Yamamoto's structure.

The Office Action relies upon Svetkoff for disclosing a solder contact that is less than 100 microns. Svetkoff, however, adds nothing to rectify the deficiencies associated with Yamamoto. Further, Applicant respectfully submits that there is no motivation to combine these references since Yamamoto teaches away from improving interconnect density.

The Office Action states that it would have be obvious to combine Svetkoff with Yamamoto "so that interconnect density can be improved and the device size/ground rules can be reduced in Yamamoto's device." (pg. 4). Applicant respectfully disagrees. Yamamoto discloses that "[a]ccording to the semiconductor device structure of the present embodiment, since those solder bumps 48 on the second connection electrodes are arranged as a matrix array . . . it is possible to make the pitch BP between the mutually adjacent solder bumps 48 very larger [sic]." (Col. 6, lines 1-8 and FIG. 6).

In other words, Yamamoto's structure allows solder bumps 48 to be spaced farther apart and teaches away from increasing the interconnect density. Consequently, there is no motivation to combine Svetkoff, which creates a higher interconnect density through a larger number of solder balls by reducing their sizes, with Yamamoto, which discloses spacing the solder balls farther apart, thereby decreasing interconnect density of the solder balls.

Claims 43-49, 68, and 74-75 depend from claim 40. Claim 72 depends from claim 71. Claims 43-49, 68, 72, and 74-75 should be similarly allowable along with their base claims for at least the reasons provided above, and on their own merits.

For example, the cited references fail to disclose or suggest "solder contacts [that] have a diameter less than 10 microns," as recited in claim 43, "solder contacts [that] have a diameter of approximately 2 microns," as recited in claim 44, or that "at least one solder contact has a diameter of approximately 2 microns," as recited in claim 71. Svetkoff is relied upon for disclosing solder balls that are 10 to 300 microns in diameter. A solder ball formed to less than 10 microns in diameter would not be rendered obvious by Yamamoto and Svetkoff, much less a solder ball that is approximately 2 microns in diameter.

Further, the cited references fail to teach or suggest that the "first insulator layer is at least 2 microns thicker than said at least one metal contact," as recited in claim 68. The Office Action asserts that Yamamoto discloses a "first insulating layer being 10-50 microns thick ([element] 41 in Fig. 7)." (pg. 7). As indicated previously, Yamamoto discloses three insulating layers; elements 24, 41, and 47, respectively. Element 41 is the second insulating layer and not the first insulating layer: layer 24 is the first insulating layer. Yamamoto does not teach or suggest a thickness for first insulating layer 24. Accordingly, Yamamoto does not disclose or suggest that the first

insulator layer is at least 2 microns thicker than the metal contact layer. These are additional reasons for the allowance of dependent claims 43, 44, 68, and 71.

Claims 50 and 51 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Yamamoto and Svetkoff, and further in view of the admitted prior art. The rejection is respectfully traversed.

Claims 50 and 51 depend from claim 40 and should be allowable for at least the reasons provided above regarding claim 40, and on their own merits. Specifically, Yamamoto and Svetkoff do not teach or suggest "a semiconductor structure having at least one metal layer . . . a first insulator layer formed on said at least one metal contact layer; at least one metal pad . . . a second insulator layer formed on said at least one metal pad and at least a portion of said first insulator layer; and at least one solder contact ball formed in the second insulator layer . . . having a diameter less than 100 microns," as claim 40 recites.

Yamamoto and Svetkoff do not disclose or suggest a first insulator layer formed on at least one metal layer with a second insulator layer formed on at least a portion of the first insulator layer, wherein at least one solder contact ball is formed in the second insulator layer. Yamamoto discloses three insulating layers, 24, 41, and 47. Yamamoto's solder bump 48 is formed in the third insulating layer 47 and not insulating layer 41. The admitted prior art is relied upon for disclosing a semiconductor device bonded to a module substrate or a circuit board, and adds nothing to rectify the deficiencies associated with Yamamoto and Svetkoff.

Claim 69 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Yamamoto and Svetkoff, and further in view of U.S. Patent No. 5,888,884 ("Wojnarowski"). The rejection is respectfully traversed.

Claim 69 depends from claim 40 and should be similarly allowable for at least the reasons provided above regarding claim 40, and on its own merits. Wojnarowski is relied upon for disclosing a pad metallization comprising four or more layers, and adds nothing to rectify the deficiencies of Yamamoto and Svetkoff.

In particular, Yamamoto and Svetkoff do not disclose or suggest a first insulator layer formed on at least one metal layer with a second insulator layer formed on at least a portion of the first insulator layer, wherein at least one solder contact ball is formed in the second insulator layer. Yamamoto discloses three insulating layers, 24, 41, and 47. Yamamoto's solder bump 48 is formed in the third insulating layer 47 and not insulating layer 41.

Claim 70 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Yamamoto, Svetkoff and Wojnarowski, and further in view of JP Pat. 408236938 ("Takashi"). The rejection is respectfully traversed.

Claim 70 depends from claim 69 which depends from claim 40. Claim 70 should be allowable for at least the reasons provided above regarding claims 40 and 69, and on its own merits. Takashi is relied upon for disclosing a metal pad comprising Zirconium, and adds nothing to rectify the deficiencies of Yamamoto, Svetkoff, and Wojnarowski.

Specifically, Yamamoto and Svetkoff do not disclose or suggest a first insulator layer formed on at least one metal layer with a second insulator layer formed on at least a portion of the first insulator layer, wherein at least one solder contact ball is

formed in the second insulator layer. Yamamoto discloses three insulating layers, 24, 41, and 47. Yamamoto's solder bump 48 is formed in the third insulating layer 47 and not insulating layer 41.

In view of the above, all of the claims are believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to pass this application to issue.

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Respectfully submitted,

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